Algae Testbed Public Private Partnership (ATP³): Enabling Algal Technology Research and Development

John McGowen PhD, PMP, Director of Operations
Arizona Center for Algae Technology and Innovation (AzCATI)
at Arizona State University

BIO Pacific Rim Conference, December 9, 2014
Establish a **sustainable network of regional testbeds** that empowers **knowledge creation and dissemination** within the algal R&D community, **facilitates innovation**, and **accelerates growth** of the nascent algal bioproducts and biofuels industry.
ATP³ primary objectives

ATP³ is a $15M Department of Energy (DOE) funded 5 year project led by ASU’s Arizona Center for Algae Technology and Innovation (AzCATI).

Collaborative Open Testbeds

• Establish **network** of facilities for the algal research community and **increase stakeholder access** to real-world conditions for algal biomass production.

• **Accelerate** applied algae research, development, investment, and commercial applications for biofuel and bioproduct feedstock production.

High Impact Data from Long Term Algal Cultivation Trials

• Design and implement a unified experimental program across different **regional, seasonal, environmental and operational conditions** comparing promising production strains at meaningful scales.

• **Data made widely available** to the TEA/LCA and overall research community allowing for a robust analysis of the state of technology.
The formation of the Algae Testbed Public-Private Partnership leveraged the existing resources at AzCATI and partner sites. The network represents a collaboration of industry, laboratory, and educational facilities across nation. ATP³ aims to convene all algae stakeholders to facilitate opportunities and progress more rapidly to commercialization.
Collaborative Open Testbeds

ATP³ offers access to a wide array of services, capabilities and facilities:

Regional testbed facilities for the partnership are physically located in Arizona, Hawaii, California, Georgia, and Florida.
Why Engage with ATP³?
ATP³: Testbeds Open for Business

- **Project Activities**: biomass supply, equipment testing, analytical testing, culture maintenance and consultation services to academia, industry and national labs

- **Project Categories**: fee-for service activities, sponsored research, and subsidized projects through ATP³ Support Program

- **Project Benefits**: to drive technology research and development, de-risk and validate technological innovations
Cultivation options – AzCATI: Platforms for indoor/outdoor experimentation
Variety of independent and vertically integrated downstream harvesting unit ops

Provide service to ATP³ customers
- Produce algal biomass in the form of slurry, paste and dry powers
- Serve as baseline technologies for the improvement of future harvesting/dewatering and oil extraction processes (Valicor and OpenAlgae platforms)

Support DOE’s TEA, sustainability, and resource modeling
- Generate harvesting data for the current harmonized model
- Provide more options to generate data on the selection of harvesting methods
- Provide feedstock for lipid extraction and other downstream product applications
An Example: Biomass Toll Production Project

- Leveraging the Helix™ photobioreactor
  - Using the Helix as semicontinuous seed platform supporting larger scale cultivation in open pond raceways (2 x 60 m²) of customer supplied proprietary strain
  - 8 week growth campaign generating 7-8 kg of biomass per batch (media recycle)
  - Total project duration 3 months (included indoor scale up)
  - ATP³ delivered biomass as whole, freeze dried product.
  - Production data through harvest
    - centrifuge and MF --> centrifuge process options evaluated
    - can be utilized for TEA/LCA (with permission from client)
Collaborative Open Testbeds: Site Access and Customer Management

**ATP³ offers a 3-tier fee structure**
- Full data confidentiality (fully burdened rate – site specific)
- Open access - willing to share data generated at test bed (discounted)
  - Level of discount site specific
- Subsidized Access (Scholarship and Innovators Awards)
  - Proposals for use of the testbed with access to materials, equipment, personnel
  - Travel support available to access sites (primarily for academics)

**Site Access Plan: Boilerplate IP, MTA, NDA, and facilities use agreement in place for customers**
- Simple templates for engagement – one off projects, longer term engagement, and engagement with facility use
- Academic unit approval only for external sales of services – **if no major changes requested, can be approved in ~1 week.**
- Can be applied as pass through to partner sites
  - AzCATI Recharge Center handles agreement and transaction and flows through funding to partner sites – only one party to negotiate with
- AzCATI has already been operating with this testbed framework for >3yrs
- Will transition to consortium based membership model as DOE funding decreases
**The Goal** – encourage and enable small businesses, entrepreneurs and underfunded academic researchers to pursue new approaches to solving technical issues associated with commercialization of algae biofuels, processes, and co-products.

**What is it?**
- Access to laboratory, outdoor facilities and resource support for novel projects
- ATP³ provides subsidized access to testbed facilities, technical expertise, and M&S
- Preference for support will be given to:
  - Short-term projects ranging from 1-3 months (typical project target $10K-$30K)
  - Researchers willing to share data and results widely through publication
  - Projects that leverage on-going activities already occurring (e.g., UFS/AFS)

**Easy to start the process:** Visit ATP3.org and fill out an expression of interest form

**Initial cohort of support projects includes:**
- Novel cultivars for flue gas capture (University of Delaware)
- Carbon management and delivery (LBNL)
- AD with LEA (Cal Poly)

**Support may include:**
- Biomass (whole, extracted, oil)
- Access to cultivation & downstream equipment (eq. transport, install/removal)
- Access to R&D, production & analytical expertise
- Access to laboratory and office space
- Travel stipends to testbed (currently limited to academic clients)

**Initial cohort of support projects includes:**
- Accepting applications for next cohort selection
• ATP³ has hosted 7 quarterly educational workshops
• Over 30 lecture modules
• Over 15 hands-on field site and laboratory activities
• Well attended by broad mix of academic and industrial participants
  • More than 200 participants representing >70 different organizations
• Most recent workshop: Large-Scale Cultivation and Downstream Processing (Nov 3-7th; Mesa, AZ)
• Compositional Analysis Workshop planned for May 2015 at NREL in Golden Colorado
Summary

- The ATP³ testbed network is up and running
- ATP³ completed projects with >24 customers in 2 years
- Streamlined business processes – can be applied to multiple sites
- Six ongoing/scheduled projects
  - Includes non-US based foreign companies looking to leverage the network with a landing pad in the US
  - Cultivation trails (including GMO), analytical support, biomass (10’s-100’s kg), equipment trials, access to facilities to conduct your own R&D, training, etc…
- Three ATP³ support projects have been accepted…two are well underway, 3 additional in pipeline for next year – looking for more
  - Great path to scale bench scale lab results (novel process ideas, strains (including GMO), out into the real world
  - New synergies/new collaborations
- Education and Training workshops have reached approximately 80 different agencies, organizations, companies and academic institutions
Acknowledgements

**ASU**
Gary Dirks
John McGowen
Thomas Dempster
Milt Sommerfeld
William Brandt
Jessica Cheng
Jordan McAllister
Sarah Arrowsmith
David Cardello
Theresa Rosov
Mary Cuevas
Jeffrey Prairie
Richard Malloy
Xuezhi Zhang
Henri Gerken
Pierre Wensel
Linda Boedeker
Sarah Mason
Travis Johnson
Sydney Lines

**NREL**
Phil Pienkos
Lieve Laurens
Ed Wolfrum
David Crocker
Ryan Davis
Stefanie Van Wychen
Eric Knoshaug

**Sandia National Labs**
Ron Pate
Todd Lane
Patricia Gharagozloo
Thomas Reichardt
Jessica Drewry
Pamela Lane

**Cal Poly**
Tryg Lundquist
Brad Crowe
Eric Nicolai

**Commercial Algae Management**
Albert Vitale
Robert Vitale

**Georgia Tech**
Yongsheng Chen
Steven Van Ginkel
Thomas Igou
Zixuan Hu

**Cellana**
Valerie Harmon
Martin Sabarsky
Emily Knurek
Kate Evans
Peter Prentiss
Reyna Javar
Kari Wolff
Keao Bishop-Yuan
Lynn Griswold
Christina Boyko
Charlie O’Kelley

**Florida Algae**
Steven Schlosser
Chris Withstandley
Mary Riddle
Nancy Pham Ho (FIT)

**ASU Undergrads**
Wyatt Western
Mariah Patton
Maria Bautista
Carlos Luna
Delaney De Hertogh
Shaylin Mcghee
Caden Offield

**GT Undergrads**
Fariha Hassan
Jerry Duncan
Frazier Woodruff
Shusuke Doi
Hao Fu
Patricia Penalver-Argueso
Allison Dunbar

**CP Undergrads**
Aydee Melgar
Gulce Ozturk
Kaitlyn Jones
Michael Antoine
Trung K Tran
Jake Bender
Heather Freed
Daniel McBroom
Michele Hendrickson

**U.S. Department of Energy**

**UTEX**
Schonna Manning
Jerry Brand

**FL**
Nancy Pham Ho (FIT)

**Sandia National Labs**
Ron Pate
Todd Lane
Patricia Gharagozloo

**Commercial Algae Management**
Albert Vitale
Robert Vitale

**Georgia Tech**
Yongsheng Chen
Steven Van Ginkel
Thomas Igou
Zixuan Hu

**Cellana**
Valerie Harmon
Martin Sabarsky
Emily Knurek
Kate Evans
Peter Prentiss
Reyna Javar
Kari Wolff
Keao Bishop-Yuan
Lynn Griswold
Christina Boyko
Charlie O’Kelley

**Florida Algae**
Steven Schlosser
Chris Withstandley
Mary Riddle
Nancy Pham Ho (FIT)